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Original Article

CHEMICAL COMPOSITION AND GROSS ENERGY CONTENT OF SWEET POTATO IN NORTH EASTERN HILL REGION OF INDIA

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ABSTRACT

The representative samples of sweet potato tuber from 10 (ten) different places of Assam, Meghalaya and Tripura were collected. Tubers of all these samples were manually chopped, boiled, dried and processed. Chemical composition and energy content of raw and boiled sweet potato were estimated. The raw sweet potato contained DM 35.61, OM 96.51, CP 5.01, EE 1.04, TCHO 90.98, CF 2.32, NFE 88.13 and TA 3.49 percent, respectively. The percentage of DM, OM, CP, EE, TCHO, CF, NFE and TA in boiled sweet potato was 35.36, 96.49, 4.31, 0.99, 91.27, 2.32, 88.85 and 3.50 per cent, respectively. The GE content of raw and boiled sweet potato was 4042.35 and 4030.05 Kcal/kg DM, respectively. Statistically no significant variations were observed among the sources in respect of CP, TCHO and GE contents of sweet potato. However, significant (P<0.05, 0.01) variations were observed among the sources in respect of DM, OM, EE, CF, NFE, TA, Ca and P contents. Statistically significant variations were observed in respect of DM, OM, EE, CF, NFE, TA, Ca and P content between different sources (locations) and CP, EE, TCHO, NFE, Ca, P and GE values in between raw and boiled sweet potatoes. In the present study, the significant variation in DM, OM, EE, CF and NFE might be due to the variation in the characteristic of soil, climate and time of collection of sweet potatoes among the sources. Significantly (P<0.01) decreased CP and GE content in boiled sweet potatoes might be due to breaking down of protein molecules and significantly (P<0.01) increased total carbohydrate and NFE content could be due to breaking down of starch molecules into simpler form. Significantly (P<0.05) decreased calcium and increased (P<0.01) phosphorus content in boiled sweet potatoes might be due to breaking down of polysaccharides to chelates cations and variation in silica content in raw and boiled sweet potatoes.

KEYWORDS: Sweet Potato, Boiled, Raw, Chemical Composition & Gross Energy

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INTRODUCTION

Sweet potato (*Ipomoea batatas*) is an annual crop in tropical countries and vines and roots are used as an excellent source of animal feed. It is high in starch and protein (Chakrabarti et al., 2014). The sweet potato (*Ipomoea batatas*) is high yielding short cycle tuber crop and rich in vitamin A, ascorbic acid, thiamin, riboflavin and niacin (Dominguez, 1991). It is also rich in phosphorus, iron and potassium (Scott, 1991, Anon, 2002), which have been found as suitable substitute for maize in livestock feeding (Job *et al*., 1979; Teguia *et al*., 1993; Yadav *et al*., 1995; Abu, 1997; Bora, 1999; Abu *et al*., 1999 and Nguyen *et al*., 2000). Sweet potatoes are a good source of energy (70% starch content) and could be used as energy feed for rabbits (Lebas *et al*., 1986). Chakrabarti *et al*. $2017_{a,}$ Chakrabarti *et al*. 2017_{b} and found sweet potato is a very good replacement of maize grain in rabbit ration and there were no adverse effect of sweet potato in physiological and blood parameters in broiler rabbit. The metabolism trial also revealed the suitability of sweet potato in broiler rabbit ration. The present study was

carried to find out the variability in proximate composition of raw and boiled sweet potato collected from different sources in North Eastern Hill Region of India to explore the inclusion of sweet potato in animal feed.

MATERIALS AND METHODS

The representative samples of sweet potato were collected from ten different places viz. Assam, Meghalaya and Tripura (Table 1). Collected samples were cleaned, washed, chopped and boiled at 100°C. The boiled sweet potato then sun dried. After sun dried, placed the samples in hot air oven at 50°C for 2 hours and then grinded. The dried sweet potatoes were then grinded. Proximate analyses were done for all the representative samples to estimate their chemical composition as per AOAC (1980). Gross energy content (as per the Gallenkamp manual), calcium and phosphorus (Talapatra *et al*., 1940) of raw and boiled sweet potato were also estimated.

The data were analyzed as per Snedecor and Cochran (1980) by using MSTATC package of Computer.

RESULTS AND DISCUSSIONS

The chemical composition and gross energy content of raw and boiled sweet potato from ten (10) different sources (locations) have been presented in Table 1.The dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), total carbohydrate (TCHO), crude fibre (CF), nitrogen free extract (NFE), total ash (TA), calcium (Ca) and phosphorus (P) content of the raw and boiled sweet potato ranged from 34.06±0.91 to 37.67±0.51 and 33.74±0.56to 37.35±0.24; 96.26±0.04 to 96.87±0.03and 96.26±0.04 to 96.89±0.00; 4.55±0.44 to 5.21±0.01 and 4.13±0.02to 4.65±0.08; 0.93±0.02 to 1.15±0.00 and 0.85±0.04 to 1.08±1.01; 89.98±0.26 to 90.85±0.48 and 90.43±0.32 to 91.70±0.08; 1.98±0.01 to 2.89±0.01 and 1.98±0.00 to 2.89±0.01; 87.25±0.02 to 88.84±0.48 and 87.53±0.31 to 89.53±0.06; 3.13±0.02 to 3.73±0.03 and 3.10±0.02 to 3.73±0.04; 0.15±0.00 to 0.21±0.01 and 0.14±0.00 to 0.21±0.00; 0.09±0.09 to 0.11±0.00 and 0.09±0.01 to 0.14±0.01 per cent, respectively, with their average values of 35.62 ± 0.28 and 35.26 ± 0.26; 96.51 ± 0.05 and 96.49 ± 0.053; 5.01 ± 0.06 and 4.31 ± 0.05;1.04 ± 0.02 and 0.99 ± 0.02; 90.38 ± 0.08 and 91.27 ± 0.10; 2.32 ± 0.07 and 2.32 ± 0.07; 88.13 ± 0.11 and 88.85 ± 0.13; 3.49 ± 0.049 and 3.50 ± 0.05; 0.18 ± 0.01 and 0.17 ± 0.01; 0.10 ± 0.00 and 0.12 ± 0.01, respectively.

The gross energy (GE) content of raw and boiled sweet potato ranged from 4031.50±3.46 to 4054.50±10.49 and 4025.50±0.00 to 4037.00±2.00 Kcal/kg, respectively with mean value of 4042.35 ± 1.83 and 4030.05 ± 0.96 Kcal/kg, respectively. Analysis of variance and critical difference test (Table 1) revealed significant differences ($P<0.05$; $P<0.01$) between sources (locations) in DM, OM, EE, CF, NFE, TA, Ca and P, but no significant differences were observed in respect of locations in CP and TCHO. The DM, OM, CF and TA did not show any significant difference between two treatments. However, the CP, EE and Ca values were significantly ($P<0.01$) lower (4.31 ± 0.05, 0.99 ± 0.02 and 0.17 ± 0.01, respectively), whereas, TCHO, NFE and P values were significantly higher ($P<0.01$) in boiled sweet potatoes (91.27 ± 0.10, 88.85 ± 0.13 and 0.12 ± 0.01, respectively). The GE content revealed significantly higher ($P<0.01$) values in raw sweet potato (4042.35 ± 1.79 Kcal/kg) than the boiled sweet potato (4030.05 ± 0.96 Kcal/kg), but no significant difference was observed due to sources.

Table 1: Chemical Composition of Raw and Boiled Sweet Potato on DM Basis Collected from Different Sources (MEAN± SE)

Source / Constituent	Agartala (Dist. West Tripura)	Udaipur (Dist. South Tripura)	Kamalpur (Dist. Dhalai)	Dharma-Nagar (Dist.North Tripura)	Shillong (Dist.East Khasi Hills)	Jowai (Dist. Jaintia Hills)	Nongpoh (Dist. Ri-bhoi)	Guwahati (Dist. Kamrup)	Lanka (Dist. Naogaon)	Silchar (Dist. Cachar)	Overall (Treatment)
1	2	3	4	5	6	7	8	9	10	11	12
DM (%)											
Raw	35.655 ±0.505	36.210 ±0.016	36.095 ±0.016	34.685 ±0.465	34.150 ±0.830	36.310 ±1.150	37.670 ±0.510	35.310 ±0.016	34.065 ±0.915	36.000 ±0.110	35.615 ±0.277
Boiled	35.065 ±0.022	35.430 ±0.070	36.005 ±0.011	34.290 ±0.280	33.740 ±0.560	36.185 ±0.016	37.350 ±0.240	35.160 ±0.049	33.750 ±0.750	35.580 ±0.400	35.256 ±0.258
Location	35.360^{a} ±0.268	35.820^{a} ±0.227	36.050^{a} ±0.026	34.487^{b} ±0.249	33.945^{b} ±0.426	36.247^{a} ±0.471	37.570^{c} ±0.248	35.235^{a} ±0.048	33.907^{b} ±0.491	35.790^{a} ±0.208	35.435 ±0.189
OM (%)											
Raw	96.495^{a} ±0.031	96.390^{ab} ±0.031	96.340^{bd} ±0.031	96.870^{c} ±0.031	96.785^{c} ±0.031	96.815^{c} ±0.000	96.470^{ae} ±0.031	96.370^{bde} ±0.044	96.335^{bd} ±0.062	96.265^{d} ±0.044	96.513 ±0.050
Boiled	96.465^{a} ±0.031	96.275^{b} ±0.044	96.330^{b} ±0.000	96.895^{c} ±0.000	96.765^{d} ±0.000	96.825^{cd} ±0.000	96.460^{ae} ±0.044	96.345^{be} ±0.000	96.325^{b} ±0.031	96.265^{b} ±0.044	96.495 ±0.053
Location	96.480^{a} ±0.018	96.332^{bc} ±0.036	96.335^{bc} ±0.000	96.882^{d} ±0.025	96.775^{e} ±0.000	96.820^{de} ±0.000	96.465^{a} ±0.031	96.357^{b} ±0.000	96.330^{bc} ±0.025	96.265^{c} ±0.031	96.504 ±0.035
CP (%)											
Raw	5.110 ±0.010	5.215 ±0.005	5.140 ±0.010	5.040 ±0.060	4.840 ±0.280	4.860 ±0.250	4.555 ±0.445	5.115 ±0.015	5.175 ±0.065	5.065 ±0.015	5.011^{A} ±0.061
Boiled	4.485 ±0.095	4.650 ±0.080	4.155 ±0.025	4.130 ±0.020	4.335 ±0.235	4.255 ±0.075	4.180 ±0.180	4.165 ±0.015	4.275 ±0.105	4.525 ±0.065	4.315^{B} ±0.047
Location	4.797 ±0.185	4.932 ±0.166	4.647 ±0.285	4.585 ±0.264	4.587 ±0.209	4.557 ±0.205	4.367 ±0.224	4.640 ±0.274	4.725 ±0.265	4.795 ±0.159	4.663 ±0.067
EE (%)											
Raw	1.150 ±0.000	1.025 ±0.015	0.930 ±0.020	1.115 ±0.005	1.135 ±0.015	1.105 ±0.015	1.065 ±0.065	0.995 ±0.015	0.985 ±0.025	0.930 ±0.040	1.043 ±0.019
Boiled	1.055 ±0.055	0.995 ±0.015	0.935 ±0.005	1.060 ±0.040	1.085 ±0.005	1.015 ±0.065	1.065 ±0.015	0.955 ±0.025	0.915 ±0.015	0.855 ±0.045	0.993 ±0.018
Location	1.102^{a} ±0.035	1.010^{bd} ±0.012	0.932^{ce} ±0.008	1.087^{a} ±0.023	1.110^{a} ±0.016	1.060^{ad} ±0.038	1.065^{ad} ±0.027	0.975^{bc} ±0.017	0.950^{bce} ±0.023	0.892^{e} ±0.033	1.018 ±0.014
TCHO (%)											
Raw	89.985 ±0.257	90.150 ±0.022	90.270 ±0.000	90.715 ±0.076	90.810 ±0.303	90.350 ±0.229	90.850 ±0.479	90.260 ±0.031	90.175 ±0.096	90.270 ±0.383	90.383^{A} ±0.082
Boiled	91.475 ±0.465	90.430 ±0.320	91.240 ±0.044	91.705 ±0.083	91.345 ±0.214	91.555 ±0.153	91.215 ±0.156	91.225 ±0.000	91.135 ±0.113	91.385 ±0.566	91.270^{B} ±0.098
Location	90.730 ±0.481	90.290 ±0.156	90.755 ±0.280	91.210 ±0.290	91.077 ±0.216	90.952 ±0.366	91.032 ±0.231	90.742 ±0.279	90.655 ±0.283	90.827 ±0.396	90.827 ±0.095
CF (%)											
Raw	2.505 ±0.005	2.895 ±0.005	2.695 ±0.015	2.170 ±0.010	2.370 ±0.010	2.575 ±0.025	2.010 ±0.000	1.985 ±0.005	2.060 ±0.060	1.985 ±0.025	2.325 ±0.072
Boiled	2.505 ±0.005	2.895 ±0.005	2.685 ±0.045	2.170 ±0.020	2.360 ±0.010	2.575 ±0.025	2.005 ±0.005	1.980 ±0.000	2.045 ±0.055	1.980 ±0.020	2.320 ±0.073
Location	2.505^{a} ±0.003	2.895^{b} ±0.003	2.690^{c} ±0.020	2.170^{d} ±0.009	2.365^{e} ±0.006	2.575^{f} ±0.014	2.007^{gh} ±0.002	1.982^{g} ±0.002	2.052^{h} ±0.033	1.982^{g} ±0.013	2.322 ±0.050
NFE (%)											

Raw	87.730 ±0.022	87.255 ±0.022	87.575 ±0.022	88.545 ±0.070	88.440 ±0.309	88.275 ±0.294	88.840 ±0.481	88.275 ±0.000	88.115 ±0.031	88.285 ±0.022	88.133^{A} ±0.115
Boiled	88.470 ±0.031	87.535 ±0.314	88.555 ±0.094	89.535 ±0.062	88.985 ±0.225	88.980 ±0.133	89.210 ±0.158	89.245 ±0.022	89.090 ±0.054	88.905 ±0.044	88.851^{B} ±0.126
Location	88.100^{a} ±0.214	87.395^{b} ±0.152	88.065^{a} ±0.286	89.040^{c} ±0.289	88.712^{cd} ±0.222	88.627^{de} ±0.242	89.025^{c} ±0.238	88.760^{cde} ±0.280	88.602^{d} ±0.282	88.595^{d} ±0.179	88.492 ±0.102
TA (%)											
Raw	3.505 ±0.005	3.610 ±0.010	3.660 ±0.010	3.130 ±0.020	3.215 ±0.005	3.185 ±0.005	3.530 ±0.030	3.630 ±0.020	3.665 ±0.055	3.735 ±0.035	3.486 ±0.049
Boiled	3.535 ±0.025	3.675 ±0.005	3.670 ±0.020	3.105 ±0.025	3.235 ±0.015	3.175 ±0.015	3.540 ±0.040	3.655 ±0.005	3.675 ±0.015	3.735 ±0.045	3.500 ±0.052
Location	3.520^{a} ±0.013	3.642^{b} ±0.019	3.665^{b} ±0.010	3.117^{c} ±0.015	3.225^{d} ±0.009	3.180^{d} ±0.007	3.535^{a} ±0.021	3.642^{b} ±0.011	3.670^{b} ±0.023	3.735^{e} ±0.023	3.493 ±0.035
GE (Kcal/kg)											
Raw	4040.000 ±5.000	4054.500 ±10.488	4031.500 ±3.464	4037.500 ±1.414	4050.500 ±1.414	4045.500 ±0.000	4041.500 ±9.487	4041.000 ±0.000	4042.500 ±2.449	4039.000 ±3.000	4042.350^{A} ±1.835
Boiled	4030.000 ±5.000	4027.000 ±1.000	4028.000 3.000	4031.500 ±0.000	4037.000 ±2.000	4030.000 ±5.000	4027.500 ±3.464	4025.500 ±0.000	4032.500 ±0.000	4031.500 ±0.000	4030.050^{B} ±0.962
Location	4035.000 ±4.082	4040.750 ±9.037	4029.750 ±2.082	4034.500 ±1.826	4043.750 ±4.000	4037.750 ±4.899	4034.500 ±5.773	4033.250 ±4.472	4037.500 ±3.055	4035.250 ±2.517	4036.200 ±1.432
Ca (%)											
Raw	0.196 ±0.001	0.175 ±0.001	0.155 ±0.002	0.152 ±0.003	0.172 ±0.005	0.175 ±0.004	0.190 ±0.004	0.215 ±0.014	0.200 ±0.010	0.191 ±0.004	0.182^{A} ±0.006
Boiled	0.186 ±0.011	0.161 ±0.005	0.154 ±0.003	0.139 ±0.004	0.158 ±0.005	0.176 ±0.001	0.176 ±0.004	0.193 ±0.012	0.208 ± 0.002	0.191 ±0.010	0.174^{B} ±0.005
Location	0.191^{a} ±0.005	0.168^{bce} ±0.005	0.155^{bf} ±0.002	0.146^{f} ±0.004	0.165^{b} ±0.005	0.176^{eg} ±0.002	0.183^{ag} ±0.005	0.204^{d} ±0.010	0.204^{d} ±0.005	0.191^{ad} ±0.004	0.178 ±0.196
P (%)											
Raw	0.114 ±0.001	0.104 ±0.004	0.097 ±0.001	0.103 ±0.002	0.096 ±0.004	0.111 ±0.006	0.105 ±0.004	0.099 ±0.006	0.095 ±0.013	0.091 ±0.011	0.102^{A} ±0.002
Boiled	0.134 ±0.022	0.142 ±0.011	0.109 ±0.007	0.110 ±0.007	0.112 ±0.013	0.145 ±0.007	0.116 ±0.003	0.129 ±0.022	0.089 ±0.008	0.103 ±0.001	0.119^{B} ±0.005
Location	0.124^{ac} ±0.011	0.123^{ac} ±0.012	0.103^{ad} ±0.005	0.106^{aef} ±0.003	0.104^{ab} ±0.009	0.128^{ce} ±0.010	0.110^{abc} ±0.004	0.114^{abc} ±0.013	0.092^{bdf} ±0.007	0.097^{bdf} ±0.006	0.110 ±0.003

N.B. Sub-class averages with at least one superscripts in common (lower case along the row and upper case along the column) do not differ significantly. (P<0.01) P<0.05.

The average value of chemical composition of sweet potato sample from ten different sources (Table 1) were comparable to the reported values of Tsou *et al.* (1989), Noblet *et al.* (1990), Dominguez (1990), Yadav *et al.* (1995) and Verma (2000). However, the percentage of DM (35.61 ± 0.28), EE (1.04 ± 0.02) and ash (3.49 ± 0.05) were lower than the values reported by Bora (1999). Verma (2000) observed the lower values of DM and CP, and higher values of CF than the present findings. The average gross energy value (4042.35 ± 1.83 Kcal/Kg) was comparable to the value reported by Yadav *et al.* (1995) and the values of Ca and P percent were similar to the values reported by Bora (1999). Statistically no significant variations were observed among the sources in respect of CP, TCHO and GE contents of sweet potato. However, significant (P<0.05, 0.01) variations were observed among the sources in respect of DM, OM, EE, CF, NFE, TA, Ca and P contents. Pathak and Jokhmola (1983) observed that the factors like soil, atmospheric temperature, humidity and dry length markedly affected on the chemical composition of plants. A higher value of crude protein and crude fibre in plants and their products is expected in the soils with high organic matter. Climate and soil fertility are the most important factors influencing the composition of grains and other seeds. The protein content of wheat, oats and barley is affected vary

materially by climate and these grains are low in protein when grown in certain districts of pacific coast region (Morrison, 1984). French (1955) in Kenya, Oyenuga (1968) in Nigeria, Devendra and Gohl (1970) in Trinidad found different chemical composition of sweet potato. In India Yadav *et al*. (1995), Bora (1999) and Verma (2000) also observed a different chemical composition in DM, CP, EE, CF, NFE, ash, Ca and P content in different places. Yadav *et al*. (1995) observed different chemical composition of sweet potatoes in two different plots of land in same place and they opined that this might be due to different cultivation practices, different varieties and nature of agronomic practices. In the present study, the significant variation in DM, OM, EE, CF and NFE might be due to the variation in the characteristic of soil, climate and time of collection of sweet potatoes among the sources. Significantly ($P<0.01$) decreased CP and GE content in boiled sweet potatoes might be due to breaking down of protein molecules and significantly ($P<0.01$) increased total carbohydrate and NFE content could be due to breaking down of starch molecules into simpler form.

Significantly ($P<0.05$) decreased calcium and increased ($P<0.01$) phosphorus content in boiled sweet potatoes might be due to breaking down of polysaccharides to chelates cations and variation in silica content in raw and boiled sweet potatoes. Wilkinson (1972) revealed that mineral concentration of forage depend on the mineral content of the soil. However, soil properties and conditions markedly affect mineral uptake and utilization of plant. Mineral composition of plants is affected by soil plant factors including pH of the soil, drainage, fertilizers, plant species and stage of maturity and interaction among minerals (Reid and Horvath, 1980). Pfander (1971) reported that alkalinity or higher pH soil might interfere with the availability and uptake of minerals by plant. Baruah (1995) observed significant differences in respect of soil pH, Ca and P contents among the livestock farms of three districts of Assam. The significant variation in total ash content of sweet potato observed in the present study might be due to the variation in various physio-chemical characteristics of soil and time of collection of sweet potatoes among the sources. The variation in the OM content might be due to the variation in the total ash content of sweet potatoes. The EE, CF and NFE might be varies due to variation in DM content of the sweet potatoes. The significant differences among the sources in respect of calcium and phosphorus content might be due to the variable amount of ionic form of calcium and phosphorus in the soil resulting in the degree of absorption by the plant (Tisdale and Nelson, 1975).

CONCLUSIONS

Sweet potato is a very good source of energy and could be successfully utilized in animal feed without any adverse effect. Due soil, environment and climatic condition the chemical composition of sweet potato varies. The starch and protein content is more in raw sweet potato and comparable to other feed ingredients used in animal feed. Boiled sweet potato is better than raw sweet potato because availability of carbohydrate and NFE is more though protein content reduces in boiled sweet potato. Moreover, it contains high calcium and phosphorus but in boil sweet potato calcium content is low but phosphorus content is more.

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